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POROUS PAVEMENT
PHASE I - DESIGN AND OPERATIONAL CRITERIA

BY

Elvidio V. Diniz
Espey, Huston & Associates, Inc.
Albuquerque, New Mexico 87110

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Project Officer

Hugh Masters
Storm and Combined Sewer Section
Municipal Environmental Research Laboratory (Cincinnati)
Edison, New Jersey 08817

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The City of Austin, Texas

MUNICIPAL ENVIRONMENTAL RESEARCH LABORATORY
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
CINCINNATI, OHIO 45268

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FOREWORD

The Environmental Protection Agency was created because of increasing public and government concern about the dangers of pollution to the health and welfare of the American people. Noxious air, foul water, and spoiled land are tragic testimony to the deterioration of our natural environment. The complexity of the environment and the interplay between its components require a concentrated and integrated attack on the problem.

Research and development is that necessary first step in problem solution and it involves defining the problem, measuring its impact, and searching for solutions. The Municipal Environmental Research Laboratory develops new and improved technology and systems for the prevention, treatment, and management of wastewater and solid and hazardous waste pollutant discharges from municipal and community sources, for the preservation and treatment of public drinking water supplies, and to minimize the adverse economic, social, health, and aesthetic effects of pollution. This publication is one of the products of that research; a most vital communications link between the research and the user community.

The development of porous pavement is a recognition of the interplay between two components of our physical environment—water and earth. Porous pavement utilization attempts to sustain physical processes ongoing under natural conditions. A reorientation of urban land use from exclusion of infiltration of surface water to enhancement of infiltration can be successful with regard to both the short and long term impact of urban development.

Francis T. Mayo, Director
Municipal Environmental Research
Laboratory

ABSTRACT

The overall objective of this research was to determine factors which influence runoff and water quality from areas using various porous pavement designs. The resulting information will be used to develop design criteria for potential porous pavement construction.

The first phase of this project, as reported herein, was to accumulate all available design, construction, and operational data for existing porous asphalt pavement areas. This report summarizes these data. Phase II of this project will compare the runoff and water quality characteristics of porous pavement to other kinds of conventional and experimental paving materials. Phase II results will be presented in a separate report.

Porous asphalt pavement consists of a relatively thin course of open graded asphalt mix over a deep base made up of large size crushed stone aggregate. The open graded asphalt mix has a minimum of fines (two percent or less passing the Number 200 sieve) and consequently forms a porous matrix for water to pass through to the gravel base and underlying ground. The water can be stored in the voids between the large gravel in the base material until it can percolate into the subbase or be drained through lateral drainage schemes. In this way, peak runoff to storm sewers or drainage channels can be reduced, ground water recharge is enhanced, and the cost of drainage improvements is reduced. The major cost reduction is a result of the elimination of curbs, drains, and storm sewers which are required under conventional drainage design. Additionally, storm water pollution and flooding can be reduced or eliminated.

Other porous pavement types include concrete lattice blocks with grass growing in the interstices (grasscrete) and a concrete mix with sufficient air voids to make it porous.

The development of porous pavement is an efficient combination of two existing highway drainage practices--open graded asphalt mix seal coats and open graded crushed stone bases. However, the installation of porous pavement is possible only on well drained soils or soils provided with additional relief subsurface drainage.

Previous experience with porous pavement by various designers, contractors, and operators, has been evaluated and reduced to specific design and operational criteria which are presented herein. A set of sample specifications is included in Appendix A to this report.

A brief discussion of the advantages, as well as, the disadvantages of porous pavement utilization, a brief history of the development and previous uses of open

graded asphalt friction courses, and a generalized computer program applicable to the design of all porous and non-porous parking areas are included in this report.

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ABBREVIATIONS

CBR	--California Bearing Ratio
cm	--centimeter
EAL	--equivalent axle load
FHWA	--Federal Highway Administration
ha	--hectare
kg	--kilogram
km	--kilometer
kPa	--kilopascal
m	--meter
m^2	--square meter
m^3	--cubic meter
mm	--millimeter
MT	--metric ton
NAVFAC	--Naval Facilities Engineering Command
O_{evap}	--evaporative outflow
O_{hors}	--horizontal outflow
O_{vert}	--vertical outflow
USEPA	--U.S. Environmental Protection Agency
WES	--U.S. Army Corps of Engineers Waterways Experiment Station

SYMBOLS

a	--cross sectional area of surface water
A	--cross sectional area of flow element
C	--input weir coefficient
E	--instantaneous evaporation
E_p	--peak evaporation rate
E_t	--total daily evaporation
h_o	--depth of dead surface storage on porous pavement
h_1	--depth of surface water at time t_1
h_2	--depth of surface water at time t_2
H	--depth of flow
ΔH_i	--change of water depth at boundary
i	--rainfall intensity

I	--inflow into the reservoir
k	--lumped coefficient for effects of slope and flow retardance
K	--permeability of flow element
l	--length of overland flow
L	--input weir length
N	--input roughness coefficient
O	--outflow from the reservoir
P	--pavement perimeter
q	--flow rate per unit width
q_e	--equilibrium flow
Q	--total mass flow rate
s	--input energy slope
S	--coefficient of storage of aquifer
Δt	--time increment
t_1	--beginning time of time increment
t_2	--ending time of time increment = $t_1 + \Delta t$
t_a	--time after rainfall has ceased
t_e	--time to equilibrium
t_c	--clock time
T	--aquifer transmissivity
v	--velocity of flow
V	--volume of aggregate
V_e	--equilibrium surface detention volume
V_o	--surface detention volume
w	--width of flow
W	--total weight of surfacing mixture
Y	--computed depth of flow

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